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A new species of *Polyarthra* Ehrenberg, 1834 belonging to the *vulgaris*-group (Rotifera: Monogononta: Synchaetidae) from Argentina, with a key to the identification of species in the Neotropical Region

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Abstract

A new species of planktonic genus *Polyarthra* Ehrenberg, 1834 was found in water bodies of north-eastern Argentina along the Paraná River and Uruguay River systems. This species, which belongs to the group that has a pair of ventral additional paddles, shares several features with other species of the genus particularly with *P. dolychoptera* Idelson, 1925, *P. luminosa* Kutikova, 1962, and *P. indica* Segers and Babu, 1999. *Polyarthra platensis* **sp. nov.** can be distinguished from other species of the genus by at least two autapomorphic traits, 1) the structure of dorsal integument and 2) the unusual heterogeneity in the composition of paddle bundles. Moreover, this species exhibits a specific combination of diagnostic features including the structure of the trophi having bare manubria, unci with a single tooth and absence of teeth before and after the strong major tooth on the rami. The discovery of this new species indicates that a revision of the genus in the Neotropical Region is pressingly needed. This study provides an updated species identification key for this genus in the Neotropical Region.

Key words: morphology, systematics, La Plata basin, South America

Introduction

Over the last century, the taxonomy of the planktonic genus *Polyarthra* has been addressed with different approaches, including extreme "splitter" and "lumper" positions (Carlin 1943; Sudzuki 1964). The comprehensive work by Koste (1978) divides the genus into three "Formenkreise" using six features as diagnostic characters among which those related to trophi morphology, at that time practically unknown for most of the species, were not included.

In the following decades knowledge about the morphology and taxonomy of *Polyarthra* increased significantly, with detailed descriptions of new species and other well-known but incompletely described ones, all of which paid close attention to the details of the trophi (Koste & Poltz 1984; De Smet *et al*. 1988; Koste & Tobias 1989; Shiel & Koste 1993; Segers & Babu 1999; Hollowday 2002; Schabetsberger *et al*. 2004). Furthermore, Segers and Babu (1999) specifically discussed the importance of considering the trophi morphology for the comprehensive understanding of the taxonomy of the genus *Polyarthra*.

In fact, Hollowday (2002), in his revision of *Polyarthra*¸ did take trophi morphology into account. Within his revision, a list of 21 nominal species was included, of which ten were considered as valid species. The remaining species are invalid, or of doubtful validity, for several reasons, in part for being insufficiently described.

Despite these improvements in the knowledge about the genus *Polyarthra* across the world, the *Polyarthra* species of the Neotropical Region remain relatively poorly known. For example, while Koste and José de Paggi (1982) listed four species, and Segers (2007) seven species, not more than two descriptions and/or illustrations of these specimens have been published. Concerning the well-documented records, Koste (1988) and Segers and

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Dumont (1995), pointed out and discussed their doubts about assigning the specimens found in Peru and Brazil, respectively, to named species, because the poorly clarified taxonomy of this genus.

Within the framework of our studies on material collected from the water bodies of the La Plata River basin, we frequently encountered populations of *Polyarthra*. On initial inspection, these populations were assigned to *P. trigla, P. vulgaris* or *P. vulgaris* s.l. However, detailed re-examination of these specimens led us to conclude that these populations represent a new species, which is described and illustrated here.

Material and methods

Samples were taken using a conical plankton net, mesh width 53 μm or a Patalas-Schindler plankton trap fitted with a 53 μm sieve bucket, and fixed in 5% formalin solution.

Under a binocular stereomicroscope Motic SMZ 140S, the specimens were picked and sorted from the samples using an Irwin loop and placed on a slide with a drop of 1:4–1:5 glycerol-water mixture. About three to four days later, the specimens were transferred onto a 1:2 ratio of a similar mixture. We used the microscope to regulate the process of increasing the concentration of glycerol, to prevent any deformation of the specimens that may be induced by an imbalance in osmotic pressures.

Detailed observations and drawings were made using a Nikon Optiphot microscope equipped with a camera lucida. Measurements of body, paddles and trophi were recorded with an ocular micrometer at 10 x 40 and 10 x 100 magnifications.

Body measurements were obtained from specimens that were in a repose position only (i.e. the paddles were adducted, not abducted), to avoid obtaining distorted measurements resulting from the radical changes in body shape that occur during the power stroke when powerful muscles are contracted (see Hochberg & Ablak Gurbuz, 2008).

Trophi morphology was studied by digesting soft tissues of specimens in a droplet of commercial sodium hypochlorite solution (ca. 10%), which yields isolated hard trophi. This process was followed under the microscope at a magnification of 40 x, until the trophi was expelled. The main procedures were performed according to the method proposed by De Smet (1998).

The material examined was deposited in the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires (MACN), in the Museo Provincial de Ciencias Naturales “Florentino Ameghino”, Santa Fe (MFA), and in the Instituto Nacional de Limnología (INALI).

Results

Polyarthra platensis sp. nov.

Type locality. Shallow lake in Reserva Ecológica U.N.L., Santa Fe (floodplain of Paraná River), Santa Fe Province, Argentina (31° 38’ 16” S 60° 40’ 21” W; temperature 27 ºC, conductivity 1065 μS.cm^{-1}, pH 8, dissolved oxygen 9 mg.l^{-1}). February 11th, 2009.

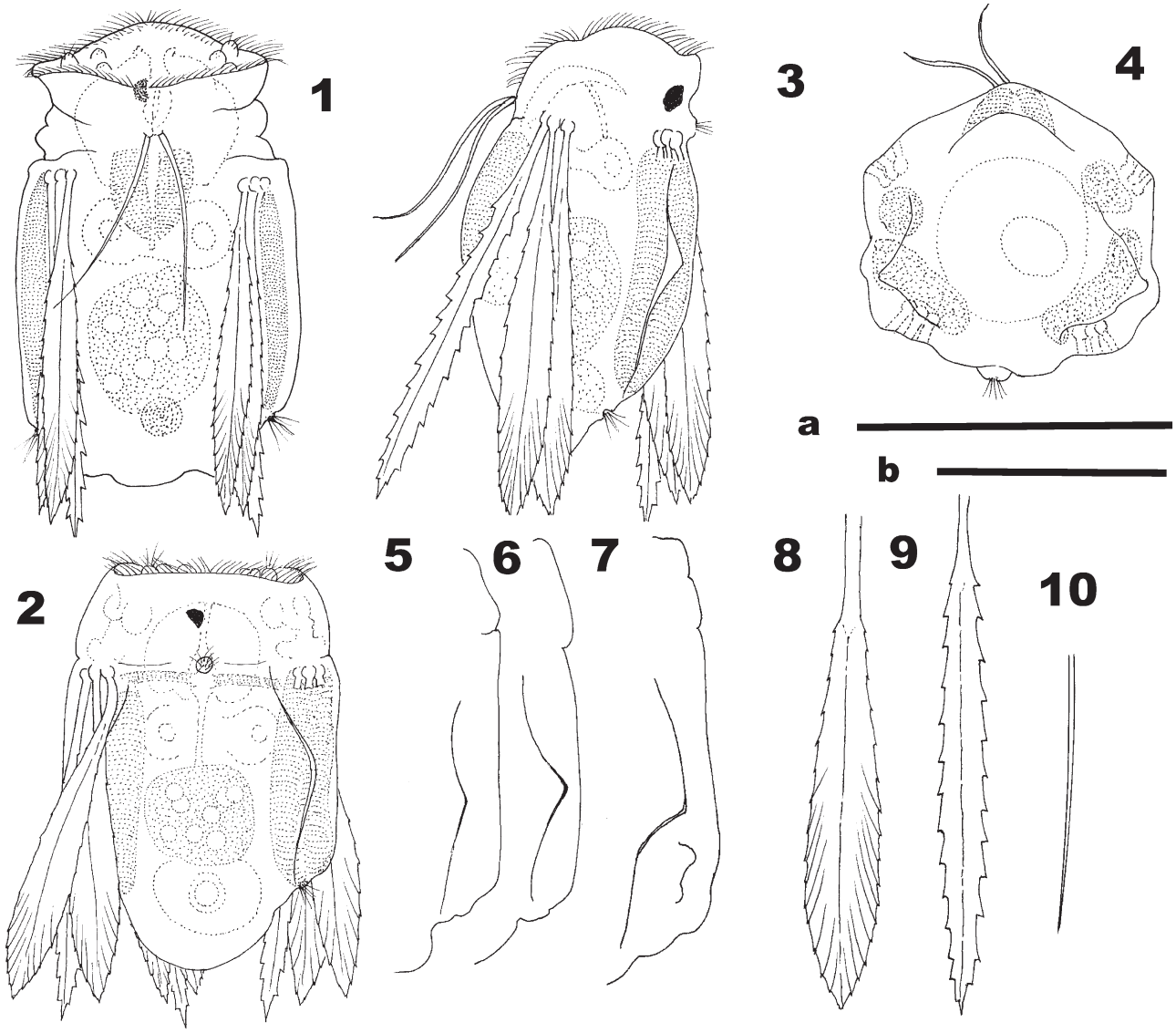
Type material. Holotype: 1 parthenogenetic ♀, complete, mounted on a slide, Accession Number MACN-In 38202. Paratypes: two parthenogenetic ♀, dissected and mounted on two slides, from type locality, Accession numbers MACN-In 38203–38204; two parthenogenetic ♀, complete, mounted on two slides, all from type locality and on the same date. Accession number MFA/Z 8 – 9.

Additional material. Numerous specimens in liquid samples, preserved in formalin deposited in INALI. Shallow lake in Reserva Ecológica U.N.L., Santa Fe (type locality), February 24th, 2009. Laguna Gonzalez, near Santa Fe (floodplain of Paraná River), Santa Fe Province, Argentina (31° 40’ 28” S 60° 34’ 11” W), November 5th, 2009. Pond situated one Km south of Cuay Grande River, Corrientes Province, Argentina (28° 41’ 41” S 56° 14’ 30” W), November 16th, 2004. Swamp at Garrucho, Corrientes Province, Argentina (28° 7’ 50” S 55° 42’ 30” W), November 16th, 2004. Pond in Saenz Peña, Formosa Province (26º 54’ 26” S 60º 27’ 37” W), December 1, 2007. The environmental conditions at all five listed sites combined were: temperature 25–27.5 ºC, conductivity 292–1065 μS.cm^{-1}, pH 7.5–9, dissolved oxygen 4.26–6.90 mg.l^{-1}.

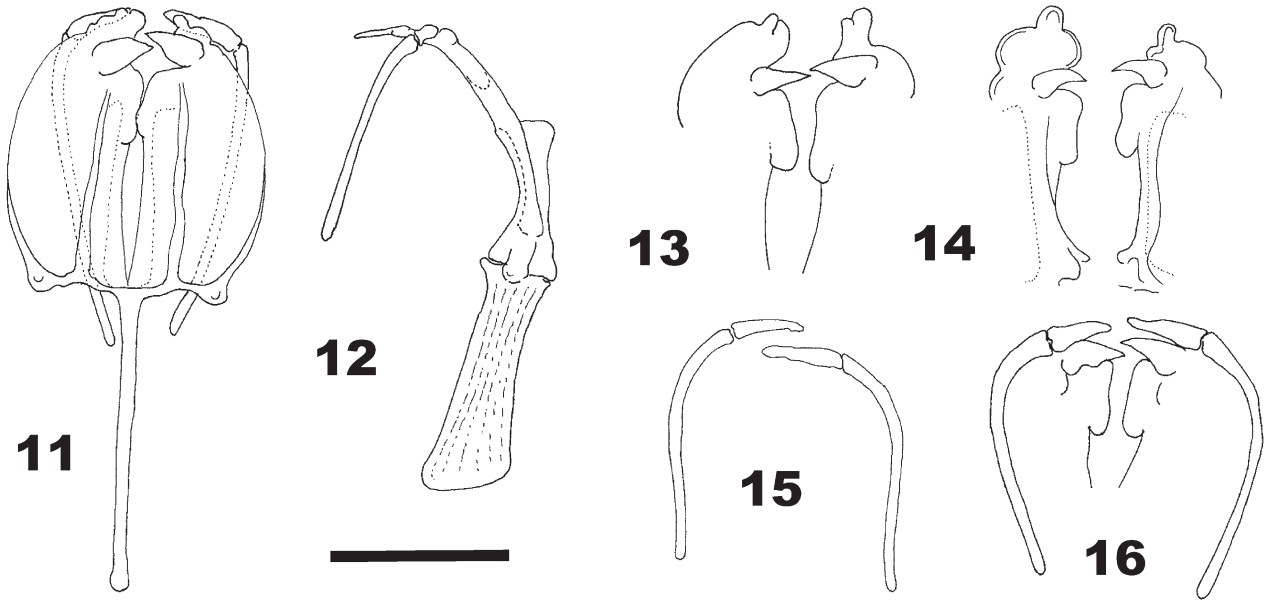
S**hort diagnosis**. *Polyarthra* with four bundles of well developed paddles, all similar in length, but shorter than body. Each bundle with two different types of paddles. Ventral accessory paddles present. Vitellarium with 8 nuclei. Unci with single tooth. Manubria gently curved in anterior half, with no projection or lamella present on its surface. Rami with single large tooth on inner margin. Distal part of rami, anterior to large tooth, round with one apical lobe.

Description of parthenogenetic female. Shape of body, in dorsoventral view, subrectangular or roughly subpentagonal (Figs. 1–2), more rarely, with lateral flanks progressively widening posteriorly. Maximum width about 60-70 % of total body length. Posterior end of body frequently produced into a wide, convex depressed process. Along the dorsal wall of the body, on both sides, and posterior to each bundle of paddles, there is an integumental expansion or ridge. This ridge is somewhat variable in shape, but could generally be described as being at an obtuse angle with the apex, located midway between the insertion of paddles and lateral antenna (Figs 2, 3, 5–7). On occasion this ridge is accompanied by a small expansions near end of body (Fig. 7). In lateral view, body progressively tapers to posteriorly, dorsal expansions do not reach outline of maximum thickness.

None of the studied specimens exhibited a "*proloba*-like" ventral protuberance. Vitellarium with 8 nuclei. However, an additional nucleus was observed in just two specimens collected from two different localities.



FIGURES 1–10. *Polyarthra platensis* **sp. nov.** (except in those cases specifically indicated all specimens are from the Paraná River floodplain): 1, Female, with head well protruded, ventral view (near Cuay Grande River, Corrientes). 2, female, dorsal view (dorsal right bundle of paddles omitted), 3, *ibid,* lateral view, dorsal right bundle of paddles omitted. 4, *ibid*, posterior view. 5–7, expansion of dorsal integument, right side. 8, lanceolate paddle. 9, ensiform paddle. 10, accessory ventral paddle. Scale bars = 50 μm, a: figs 8–10, b: figs 1–7.



FIGURES 11–16. *Polyarthra platensis* **sp. nov.**: 11, trophi, ventral view. 12, *ibid*, lateral view. 13, rami, distal part (straightened by crushing with a coverslip) 14, idem (swamp at Garrucho, Corrientes) 15, mallei. 16, mallei and details of distal part of rami. Scale bar = 20 µm .

Corona with relatively long cilia, one wide and low ciliate protuberance in central part, a pair of short, inconspicuous apical antennae close to outer limit of corona and two short protuberances positioned close to each antenna (Figs. 1–3). Eyespot conspicuous and relatively large (6.5–7% of body length), dark-red in colour and hemispherical in shape, with a posterolateral inclination of its plane (Figs. 1–2).

Dorsal antenna, easily visible due to a thickening that partially surrounds the pore, located midway between dorsal bundles of paddles (Figs. 2–3). Lateral antennae, not so conspicuous, located close to distal insertion of paddle muscles (Fig. 2).

Four bundles of major paddles located close to limit between head and rest of body. Each bundle with three paddles similar in length extending beyond the posterior end of the body by about 20–25 % of paddles length. Paddle bundles comprise two lanceolate and one ensiform paddle, all 10–20% shorter than body length, with a well-defined central longitudinal vein. Lanceolate paddles with maximum width, 13–15 % of length, at distal fourth fifth; with 14–17 short teeth on each side, those on distal third as end of a sort pattern of oblique veins or pleats (Fig. 8). Ensiform paddle, slightly longer than lanceolate paddles, with maximum width, 7–9 % of length, at middle; margins coarsely serrated, with 11–14 well defined larger teeth and surface of blade smooth (Fig. 9). Accessory pair of ventral paddles, ligulate and extremely slender, basal width 2.5–3.0 % of length, with smooth margins and as long as or slightly shorter than half of body length, inserted midway between ventral bundles (Figs. 1, 3, 4 and 10).

Throphi virgate, about half as long as body, somewhat poorly sclerotized (Fig. 11). In ventral view, fulcrum seems to be as long as rami, bacilliform with a small rounded expansion at distal end; in lateral view, shorter than rami, subrectangular, with dorsal margin straight and ventral margin concave, expanded at distal end (middle height = 16–17 % of length and distal height = 28–29 % of length) (Figs. 11–12).

In lateral view, it can be seen that rami are longer than fulcrum and curved from coronal plane to transverse plane (Fig. 12). Basal apophyses half as long as fulcrum and perpendicular to longitudinal axis of trophi, with distal part ending in a rounded, posteriorly expanded protuberance. Outer half of each ramus subhemicircular, with thin lamella whose anterior limit is barely visible. Inner part of each ramus with one conspicuously stout conical tooth at beginning of distal fourth; anterior to this tooth there is a rounded structure with one lobule at tip; posterior to stout conical tooth there is a sort of smooth flap followed by a smooth, gently concave margin (Figs. 13–14). Manubria rod-like, slender and curved, with distal part straight or slightly recurved in dorsoventral view; approximately as long as fulcrum; smooth surface without lamella (Figs. 15–16). Unci approximately as long as one third of manubria, tapered into one relatively blunt tip (Figs. 15–16).

Dimensions (in μm, mean ± standard deviation; n = 20). Body: length = 86.4 ± 7.0, width = 58.8 ± 4.7, height = 53.0 ± 2.4. Paddles: major lanceolate, length = 75.7± 5.3, width = 10.7 ±1.0; major enciform, length = 77.2 ± 3.4, width = 6.7 ± 1.1; accessory ventral, length = 38.2 ± 10, width = 1.1 ± 0.1. Trophi: total length = 41.3 ± 2.4 [48.5 ± 2.7]; fulcrum length = 20.9 ± 0.8, rami: length = 19.7 ± 9.8 [26.0 ± 0.9], width 10.8 ± 1.5; manubria length = 23.4 ± 1.5; unci length = 6.7 ± 0.5.

Due to the rami being curved in a sagittal plane two measurements are given for total length and rami length: 1) in ventral view, with coverslip supported on plasticine so as not to compress the trophi, 2) between square brackets, in lateral view or in ventral view but with rami straightened by crushing with a coverslip.

Etymology. The specific name refers to the origin of the studied material, which is water bodies located within the La Plata River Basin. La Plata Basin or Cuenca del Plata is the largest water system in South America.

Differential diagnosis and discussion. *Polyarthra platensis* **sp. nov.** should be included in the "*P. vulgaris* group" due to the presence of ventral accessory paddles and taking into account certain features of the trophi. The species may be considered phylogenetically close to *P. dolichoptera* Idelson, 1925. However, there are several consistent differences between these two species. First, there are two characters that seem to be autapomorphic to *P. platensis*; specifically 1) the presence of a pair of lateral, normally angled expansions of dorsal integument and 2) the peculiar morphological heterogeneity of the main paddles.

The unusual presence of the lateral expansion of dorsal integument has not been reported before in any of the other species in the genus and may be interpreted as a hydrodynamic adaptation associated to the rapid skipping motion used to avoid predators, which is typical of the species of this genus.

Jersabek *et al.* (2003) show a photograph of a specimen, in lateral view, questionably identified as "*P. luminosa?* Kutikova, 1962" (Catalog Number: ANSP 749), with a morphological feature that resembles this integumental expansion. However, it is not discernable in the dorsal view photographs of the same specimen. In comparison, the lateral expansions of integument are readily visible in dorsal view in *P. platensis*, even at low magnification.

With respect to the morphological differences between paddles within a bundle, at least two other cases are known, in *P. luminosa* Kutikova, 1962 and *P. minor* Voigt, 1904. However, in both species this morphological heterogeneity is constrained to either the dorsal bundles, and only to the left dorsal bundle in *P. minor.* Of additional note, *P. minor* does not belong to "*P. vulgaris*-group" because it lacks the accessory ventral paddles. In *P. platensis* **sp. nov.**, all bundles have the same pattern of heterogeneity, while the distinct paddle in *P. platensis* **sp. nov.** is ensiform, in *P. luminosa* and *P minor* are dagger-shaped (i.e. leaf-shaped but widest in the proximal part).

Apart from these autapomorphies, *P. platensis* **sp. nov.** and *P. dolichoptera* may be differentiated by the following features: 1) in *P. dolichoptera* the general body shape tapers to posteriorly, while in *P. platensis* **sp. nov.** the posterior part is not tapered; 2) the main paddles in *P. dolichoptera* are as long as, or longer than the body, while in *P. platensis* **sp. nov.** the paddles are shorter than the body; 3) the ventral accessory paddles of *P. dolichoptera* have serrated edges and are relatively shorter: ca. one fourth of the main paddle length, while in *P. platensis* **sp. nov.** these paddles have smooth margins and are somewhat more than half as long as the major paddles; 4) in *P. dolichoptera* the manubria have well-developed lamellae, while in *P. platensis* **sp. nov.** lamellae are absent; and 5) in *P. dolichoptera* the basal apophyses of rami have a knob-like recurved (anteriorly directed) termination, while in *P. platensis* **sp. nov.** the protuberance is directed to posteriorly .

Other differences also exist, which are not easy to circumscribe in terms of shape or size, but are clearly identifiable when specimens are compared. Examples include, the shape of the tips and inner margin of the rami, the size of the teeth, and the basal structure of the rami.

P. platensis **sp. nov.** also shares several features with *P. luminosa.* However, these two species are clearly distinguished by the following features: 1) in *P. luminosa* the shape of the accessory paddles is broad, lanceolate and with serrated edges, while in *P. platensis* **sp. nov.** these paddles are narrow, ligulate, and with smooth edges; 2) in *P. luminosa* the manubria have a lamella, while in *P. platensis* **sp. nov.** the manubria are subcyclindrical and bare; 3) in *P. luminosa* the unci are almost as long as the manubria, while in *P. platensis* **sp. nov.** the unci are definitely shorter, measuring about one third of the length of the manubria; 4) in *P. luminosa* the outer side of rami are bare, while they have a wide lamella in *P. platensis* **sp. nov.**; and 5) in *P. luminosa* the basal apophyses are bifurcated terminally, while in *P. platensis* **sp. nov.** they end in a knob.

In *P. platensis* **sp. nov.**, the anterior end of the rami (after the major tooth) resembles that of *P. indica*, described by Segers and Babu (1999). However, *P. indica* has four alternating teeth that precede the major tooth, while the

manubria have a well-developed lamella, and the paddles are homogeneous in shape. Specimens of *Polyarthra* from the Broa reservoir in Brazil were named '*Polyarthra* sp. near *vulgaris* Carlin' by Segers and Dumont (1995). Because this species is also a member of the *vulgaris*-group, similarities exist with *P. platensis* **sp. nov.** However, the former species has a number of traits that differ from *P. platensis* **sp. nov.**, such as, the shape of accessory ventral paddles, the absence of a pair of dorso-lateral expansions of the integument, the homogenous shape of the main paddles, and several details of trophi structure.

The discovery of this new species, which, at first glance, is easily assignable to the *P. vulgaris*-group, suggests that a revision of the genus in the Neotropical region is pressingly needed.

Key to the identification of *Polyarthra* species in the Neotropical Region

1	Accessory pair of ventral paddles absent 2
-	Accessory pair of ventral paddles present 3
2	Major paddles lanceolate, broad, 5 to 7 times as long as width, teeth with oblique, submarginal pleats. Inner margin of anterior part of rami, before to the major tooth, denticulate, posterior part smooth. Manubria stout, 11–12 times as long as mean width; with an outer angular projection medially. . . . . *Polyarthra major* Burckhardt, 1900
-	Major paddles ensiform, narrow, 10 to 14 times as long as width, teeth without submarginal pleats. Inner margin of anterior part of rami, before the major tooth, smooth, posterior part , denticulate. Manubria slender, 30 to 32 times as long as mean width; without any projection . . . . . *Polyarthra remata* Skorikov, 1896
3	Major paddles homogeneous in shape, fulcrum shorter or longer than rami 4
-	Major paddles heterogeneous in shape, fulcrum as long as rami 5
4	Major paddles narrow, 12–13 times as long as width; accessory ventral paddles bristle-like; anterior half of inner margin of rami finely denticulate; unci with three teeth; fulcrum longer than rami . . . . . *Polyarthra longiremis* Carlin, 1943
-	Major paddles moderately broad, 5–7 times as long as width; accessory ventral paddles ligulate with denticulate margin; inner margin of rami with anterior third broadly rounded and middle third asymmetrical, with two teeth and one semicircular concavity at one side, and one tooth followed by a semicircular expansion at the other side; unci with single tooth; fulcrum shorter than rami . . . . . .*Polyarthra vulgaris* Carlin, 1943
5	Major paddles similar in shape, but those of ventrolateral bundles widest at distal half and those of dorsolateral paddles widest at proximal half; accessory paddles broad, lanceolate with serrated edges; manubria with lamella; manubria and unci, practically equal in length; no lateral expansion of dorsal integument . . . . . *Polyarthra luminosa* Kutikova, 1962
-	Major paddles within all bundles with the same pattern of shapes, one ensiform plus two lanceolate; accessory paddles narrow, ligulate with smooth edges; manubria without lamella; unci definitely shorter than manubria; dorsal integument with a pair of lateral, normally angled, expansions . . . . . .*Polyarthra platensis* **sp. nov.**

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